$(\ln x)\left(\frac{1}{x}\right)$

$$\int \frac{\ln x}{x}\,dx = \int u\,du$$

$u = \ln x$

$du = \frac{1}{x}\,dx$

$x\,du = dx$

$$= \frac{u^2}{2} + C$$

$$= \frac{(\ln x)^2}{2} + C$$

$$\frac{d}{dx}(\quad) = \frac{2(\ln x)^1}{2}\left(\frac{d}{dx}\ln x\right) = \frac{\ln x}{x}$$

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$$\frac{d}{dx}\Big(f(g(x))\Big) = f'(g(x)) \cdot g'(x)$$

$$\int f'(g(x)) \cdot g'(x)\,dx = f(g(x)) + C$$

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More complicated

Complicated anti-derivatives

$$\int \ln x \, dx$$

$$\frac{d}{dx}\left(x\ln x - x\right) = (1)(\ln x) + x\left(\frac{1}{x}\right) - 1$$

$$= \ln x + 1 - 1 = \ln x$$

Product Rule

$$\int \left(\frac{d}{dx}(f \cdot g)\right) dx = \int f' g \, dx + \int f g' \, dx$$

$$f \cdot g \text{ "}+C\text{"} = \int f' g \, dx + \int f g' \, dx$$

$$+C + \quad f \cdot g - \int f' g \, dx = \int f g' \, dx$$

$$\int f g' \, dx = fg - \int f' g \, dx + C$$

$$\int u \, dv = uv - \int v \, du$$

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$$\int \ln x \, dx = x \ln x - \int (x)\left(\frac{1}{x}\right) dx$$

$$u = \ln x \qquad dv = (1)\, dx$$

$$du = \frac{1}{x} dx \qquad v = x$$

$$= x \ln x - \int 1 \, dx$$

$$= x \ln x - x + C$$

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$$\int fg'\,dx = fg - \int f'g\,dx + C$$

$$\int u\,dv = uv - \int v\,du$$

$$\int x \ln x\,dx = \left(\frac{x^2}{2}\right)\ln x - \int \left(\frac{x^2}{2}\right)\left(\frac{1}{x}\right)dx$$

$u = \ln x \qquad dv = x\,dx$

$du = \frac{1}{x}dx \qquad v = \frac{x^2}{2}$

$$\frac{x^2}{2}\ln x - \int \frac{x}{2}\,dx$$

$$\frac{x^2}{2}\ln x - \frac{1}{2}\int x\,dx$$

$$\therefore \frac{x^2}{2}\ln x - \frac{x^2}{4} + C$$

$$\int xe^x\,dx =$$

$u = x \qquad dv = e^x dx$

$du = dx \Leftrightarrow v = e^x$

$$xe^x - \int e^x\,dx$$

$$= xe^x - e^x + C$$

$$\int xe^x\,dx =$$

$u = e^x \qquad dv = x\,dx$

$du = e^x dx \qquad v = \frac{x^2}{2}$

$$e^x\left(\frac{x^2}{2}\right) - \int \frac{x^2}{2} e^x\,dx$$

$$\int x \sin x \, dx$$

$u = x \qquad dv = \sin x \, dx$

$du = dx \qquad v = -\cos x$

$$= -x\cos x - \left(\int -\cos x \, dx\right)$$

$$= -x\cos x + \sin x + C$$

$$\int e^x \sin x \, dx =$$

$u = \sin x \quad dv = e^x dx$

$du = \cos x \, dx \quad v = e^x$

$$e^x \sin x - \int e^x \cos x \, dx = e^x \sin x - \left[e^x \cos x + \int e^x \sin x \right]$$

$u = \cos x \quad dv = e^x dx$

$du = -\sin x \, dx \quad v = e^x$

$$\int e^x \sin x \, dx = e^x \sin x - e^x \cos x - \int e^x \sin x \, dx$$

$$+\int e^x \sin x \, dx \qquad\qquad + \int e^x \sin x \, dx$$

$$2\int e^x \sin x \, dx = e^x \sin x - e^x \cos x$$

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$$\int \frac{x^2+2}{x+2}\,dx$$

$$\begin{array}{r} x-2 \\ x+2\,\overline{)\,x^2+2} \\ -(x^2+2x) \\ \hline -2x+2 \\ -(-2x-4) \\ \hline 6 \end{array}$$

$$= \int x-2+\frac{6}{x+2}\,dx$$

$$= \frac{x^2}{2}-2x+6\ln|x+2|+C$$

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$$\int (f(g))' = \int f'(g) \cdot g'$$

$$f(g) = \int f'(g(x)) \cdot g'(x)\,dx$$

$$\int e^x (1+e^x)^5 \, dx = \int u^5 \, du$$

Let $u = 1+e^x$

$du = e^x \, dx$

$$= \frac{u^6}{6} + C$$

$$= \frac{(1+e^x)^6}{6} + C$$

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$$\int xe^x\,dx$$

$$= xe^x - e^x + C$$

$$\frac{d}{dx}\left(xe^x - e^x + C\right) = (1)e^x + x(e^x) - e^x = xe^x$$

More complicated Complicated
anti-derivatives

$$\int \frac{d}{dx}\left(f(x)\cdot g(x)\right)dx = \int f' g\,dx + \int f g'\,dx$$

$$fg = \int f' g\,dx + \int f g'\,dx$$

$$-\int f' g\,dx \quad -\int f' g\,dx$$

$$fg - \int f' g\,dx = \int f g'\,dx$$

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$$\boxed{\begin{aligned} fg - \int f'g\,dx &= \int fg'\,dx \\ \int u\,dv &= uv - \int v\,du \end{aligned}}$$

$$\int (x)(e^x\,dx) = xe^x - \int e^x\,dx = xe^x - e^x + C$$

$u = x \qquad dv = e^x\,dx$

$du = 1\,dx \qquad v = e^x$

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$$\int u\,dv = uv - \int v\,du$$

$$\int \ln x \, dx = x\ln x - \int x\left(\tfrac{1}{x}dx\right)$$

$$= x\ln x - \int 1\,dx$$

$$= x\ln x - x + C$$

$u = \ln x \qquad dv = 1\,dx$

$du = \frac{1}{x}\,dx \qquad v = x$

$$\int u\,dv = uv - \int v\,du$$

$$\int x \ln x\,dx = \frac{x^2}{2}\ln x - \int \frac{x^2}{2}\left(\frac{1}{x}\right)dx$$

$u = \ln x \quad dv = x\,dx$

$du = \frac{1}{x}dx \quad v = \frac{x^2}{2}$

$$= \frac{x^2}{2}\ln x - \int \frac{x}{2}\,dx$$

$$= \frac{x^2}{2}\ln x - \frac{x^2}{4} + C$$

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$$\int x\cos x\,dx =$$

$u = x \qquad dv = \cos x$

$du = dx \qquad v = \sin x$

$$\int x\cos x\,dx = x(\sin(x)) - \int \sin x(dx)$$

$$= x\sin(x) + \cos x + C$$

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$$\int e^x \cos x\,dx$$

$u = e^x \quad dv = \cos x\,dx$

$du = e^x\,dx \quad v = \sin x$

$$\int e^x \cos x\,dx = e^x \sin x - \int e^x \sin x\,dx$$

$u = e^x \quad dv = \sin x\,dx$

$du = e^x\,dx \quad v = -\cos x$

$$\int e^x \cos x\,dx = e^x \sin x - \left[e^x \cos x + \int e^x \cos x\,dx \right]$$

$$\int e^x \cos x\,dx = e^x \sin x + e^x \cos x - \int e^x \cos x\,dx$$

$+\int e^x \cos x\,dx$! $\qquad + \int e^x \cos x\,dx$

$$\therefore 2\int e^x \cos x\,dx = e^x \sin x - e^x \cos x$$

and

$$\int e^x \cos x\,dx = \frac{e^x \sin x - e^x \cos x}{2}$$

8.2/4

$$\int x^2 e^{-2x}\,dx$$

$u = x^2 \quad dv = e^{-2x}\,dx$

$du = 2x\,dx \quad v = -\frac{1}{2}e^{-2x}$

$$= -\frac{x^2}{2}e^{-2x} + \int \left(\frac{1}{2}e^{-2x}\right)(2x\,dx)$$

$$= -\frac{x^2}{2}e^{-2x} + \int x e^{-2x}\,dx$$

$u = x \quad dv = e^{-2x}\,dx$

$du = dx \quad v = -\frac{1}{2}e^{-2x}$

$$= -\frac{x^2}{2}e^{-2x} + \left[-\frac{1}{2}xe^{-2x} - \int -\frac{1}{2}e^{-2x}\,dx\right]$$

$$= -\frac{x^2}{2}e^{-2x} - \frac{x}{2}e^{-2x} + \frac{1}{2}\left(-\frac{1}{2}e^{-2x}\right) + C$$

$$\int e^{-2x}\,dx$$

$u = -2x$

$du = -2\,dx$

$-\frac{1}{2}du = dx$

$$-\frac{1}{2}\int e^u\,du$$

$$= -\frac{1}{2}e^u + C$$

$$= -\frac{1}{2}e^{-2x} + C$$

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